

THE EFFECTS OF USING STEM PROJECT-BASED LEARNING ACTIVITIES ON ENVIRONMENTAL PROBLEM-SOLVING ABILITY OF UPPER SECONDARY SCHOOL STUDENTS IN BANGKOK METROPOLIS

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ABSTRACT

This research purposed to study the effects of using STEM projects, on environmental problem-solving ability of upper secondary school students. The samples were 69 students, who enrolled in course “Science Project 1” in the first semester of academic year 2017. They were divided into three groups: high, moderate, and low science performance. There were two research instruments in this study: 1) STEM project-based learning lesson plans with five stages: 1.1) Problem defining, 1.2) Problem cause analyzing, 1.3) Possible solution generating, 1.4) STEM projects creating and 1.5) Solution evaluating, and 2) the environmental problem-solving ability test. The validity of instrument was examined by three experts in the area of science education and environmental science. The data were analyzed by arithmetic mean, standard deviation, and dependent sample t-test. The findings were found that 1) All students can create the STEM projects and use them to solve an environmental problem in community practically, 2) there was statistically significant difference of environmental problem-solving ability scores before and after using STEM projects lesson plans at.05 level in all levels of students’ performance.

KEYWORDS: *STEM Project-based Learning, Environmental Problem-solving Innovations, Environmental Problem-solving Ability & Science Teaching*

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INTRODUCTION

Background of the Study

Nowadays, the global of education in the 21st century is rapidly changing. The advancements in technology and communication assist students search for knowledge from many different learning resources in anywhere and anytime. Currently, students are learning continually because they have portable Notebooks, Tablets, and Smart Phones as the learning tools which can make all teachers become only the encouraging and facilitating persons to encourage students to develop themselves; therefore, Thai Government supports and promotes the teachers can select the teaching methods response to the change of student learning behavior and new paradigm of education in the 21st century. Moreover, there are many articles reveal that the body of knowledge in science and technology can reform the country's knowledge base as well. Thus, the principles and the integration of scientific knowledge and technology like the interdisciplinary learning in termed STEM (Science, Technology, Engineering and Mathematics) are contained in a new science curriculum B.E.2560. (Chamrat, 2016: 136-139; Pholpasri, 2011; Samad and Osman, 2017: 259-266; Siriphatrachai, 2013)

STEM Education seems all of management science, can integrate learning i.e. science, technology, engineering and mathematics comes together through the management science learning activities. They have been designed with an emphasis on teaching problem solving associated with daily life experience. The students solve the problem by creating projects in which students need applied knowledge and skills from science mentioned all through the Engineering Design Process. It is for this reason why STEM education with concepts in a manner that is integrated across subjects (Interdisciplinary Integration) which are often used by teachers how to teach science by teaching problem solving activities (Scientific Activities Problem-Based). It also teaches the learner can develop innovations and ideas from learning through information technology. (Panich 2013; Siriphatrachai, 2013; Thongchai, 2013)

In addition, the National Science Education Curriculum revised B.E. 2560 defines above areas of teaching content as eight standards are respectively, 1. physical sciences, 2. biological sciences, 3. earth science & space, 4. physics, 5. chemistry, 6. biology, 7. astronomy and space, and 8. technology that the whole elements of the curriculum in the areas; teaching content; measuring and evaluating learning are especially important in the foundations of science learning of students in each class, there is a continuum linking together. Therefore, the teaching of science has the main goal is to make students understand principles and basic rules in theory of science, to understand the scope and limitations of nature in the context of science, to realize the relationship between science, technology, the environment and mankind's positive to influence and impact each other, and to have the ability to solve problems also, can manage through different forms of technology. (Office of the Basic Education Commission (OBEC), 2016: 42-44)

To response the above stands of science learning, environmental circumstance is vast amount such as soil, water, air, plant, animals, people and substances which there are many different types are related to the daily life of human beings, all that combined ecological system. There is the ecosystem in a diverse world, various changes have occurred always may vary according to the nature or changes resulting by human acts. These changes may result in ecosystem imbalances because of the wide variety of biodiversity are important to human beings, which everyone should be engaged in the care of the environment and maintain the existing use of natural resources with care and do not affect the environment, but if the environment resulting in degraded or polluted then occurs. Students need to find the ways to solve the problem of environmental development, conservation back can apply to anyone, and practice to achieve sustainable use, too (Kasetsart University, 2017; Office of the Basic Education Commission (OBEC), 2016: 42-44).

So, the workaround into the problem solving, to see the defects from the ambient that depending on the geography and the human's life, Sripatum University, (2012) by which explains more about how make the solutions to manage environmental matters. Teachers should focus on giving students have developed the necessary core skills which include: 1. the use of others foreign languages, 2. mathematics, 3. science, 4. geography, 5. learning and innovation skills, such as critical-thinking and problem solving, 6. creative thinking and information technology, and 7. life and work skills, rather than focus on teaching in the textbooks. Therefore, from educational backgrounds where all the above. So, researchers are interested in the effects of using STEM projects on environmental problem-solving ability of upper secondary school students in Bangkok Metropolis.

Conceptual Framework

The conceptual framework is illustrated in the diagram as below:

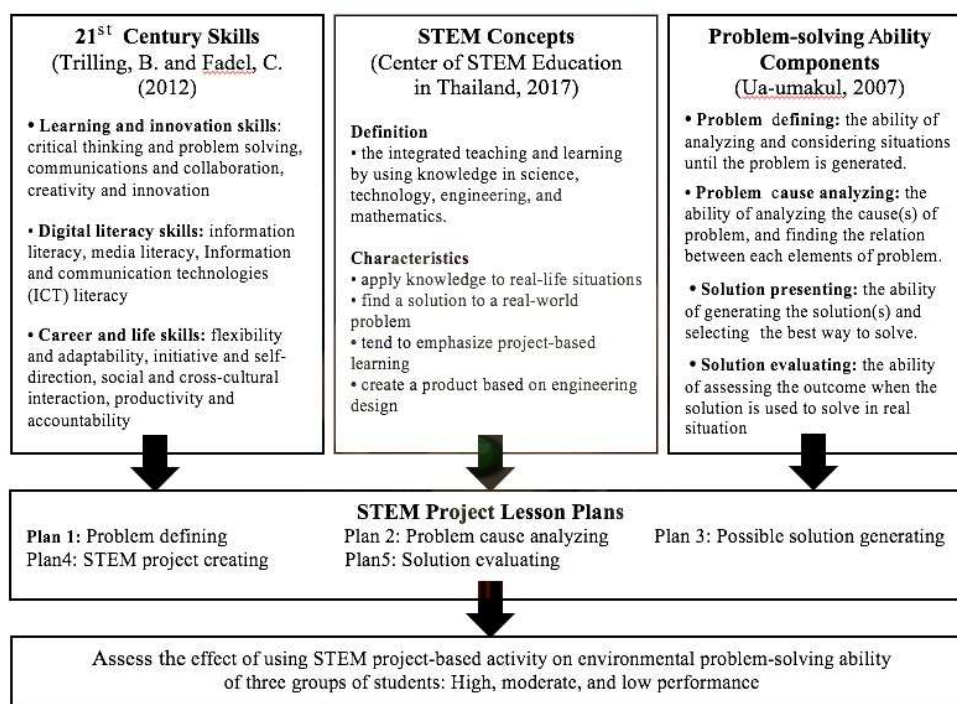


Figure 1: The Conceptual Framework

Research Objective

The objective of this study was to construct the STEM project-based learning lesson plan in order to assess the effect of using STEM project-based activity on environmental problem-solving ability of upper secondary school students in Bangkok Metropolis.

Research Question

This study purposed to answer the question whether there would be on possible effects of the using STEM project-based activity on environmental problem-solving ability of upper secondary school students under study.

Research Hypothesis

The study is hypothesized that, there was statistically significant difference in environmental problem-solving ability scores, before and after using STEM projects lesson plans, at .05 level in all levels of students' performance.

METHODS

Participants of the Study

The participants were 69 students, who enrolled in "Science Project 1" course in the first semester, academic year 2017 at government secondary school, in Bangkok Metropolis. Their participations were on a voluntary basis; their demographic variables included program of the study, gender and age. They were grouped at three performance levels, by GPA in the semester prior to the study as low, moderate, and high, with 23 members per groups.

The Construction of Research Instruments

There were two research instruments in this study: (1) Five STEM project-based learning lesson plans, and (2) the

platform and exit tests assessing environmental problem-solving ability score before and after leaning through STEM project-based activity. The details were given below:

- **STEM Project-Based Learning Lesson Plans**

The researchers conducted five STEM project-based learning lesson plans which were validated by three experts in the area of science education and environmental science for content validity, and then tried out before using plans in actual study. The IOC was higher than 0.5 and language used were edited. The five lesson plans were arranged as follows: 1.1) Problem defining, 1.2) Problem cause analyzing, 1.3) Possible solution generating, 1.4) STEM project creating, and 1.5) Solution evaluating.

- **The Environmental Problem-solving Ability Test**

The researchers constructed the environmental problem-solving ability test to assess environmental problem-solving ability score before and after leaning through STEM project-based activity. The items were in three short essays format according to the four components of problem-solving ability: 2.1) Problem defining, 2.2) Problem cause analyzing, 2.3) Solution presenting, and 2.4) Solution evaluating. The test items were validated by three experts in the area of science education and environmental science for construct validity and then tried out for difficulty (p), discrimination (r), and reliability. The results were: 1) IOC was higher than 0.5 in all items; 2) the range of difficulty and discrimination was 0.34 - 0.54 and 0.28 – 0.61, respectively; and 3) the reliability analyzed with Alpha Cornbach coefficient was 0.77.

Data Collection and Analysis

Data were collected in the first semester of academic year 2017. The procedure of data collection was in the following steps:

- The first, researchers asked the school director for permission to collect data for the study and he allowed us taking 16 weeks for using STEM project-based lesson plans and the environmental problem-solving tests.
- The researchers explained before class an overview of course, objectives, conditions, and the assessments to the students participating in the study (1st week).
- The platform test was used before the using the first STEM projected-based lesson plan (1st week).
- The lesson plans were used from the second week to the fifteenth week. The stage of using plans shown in Table 1 below:

Table 1: Time Schedules for Using STEM Project-based Lesson Plans and Learning Activities

Week / Topics	Learning Activities
2 nd – 4 th Problem Defining	Student grouped to make a project and started a work by surveying the environmental problem in their communities, and interviewing community leaders to study the state of environmental problem such as water pollution, air pollution, lack of eco-friendly energy, and so on.
5 th – 6 th Problem cause analyzing	Students interviewed the environmental leaders and/or folk philosophers, and studied in the related documents about the selected environmental problem to define the cause(s) of problem.

Table 1: Contd.,	
7 th – 8 th Possible solution generating	Students studied the previous senior projects and related documents to generate the possible solutions of selected problem and design the invention to solve the selected one.
9 th – 13 th STEM project creating	Students created the invention or model for solving their selected environmental problem under supervising of advisors.
14 th – 15 th Solution evaluating	Students evaluated the effectiveness of invention. Then, they tried out the invention or model in real situation, collect data, and presented in their reports.

- The exit test was used after the using the last STEM projected-based lesson plans (16th week).
- The student's scores of each group before and after using STEM projected-based lesson plans were also analyzed for differences by t-test for dependent samples, arithmetic mean, and standard deviation.

THE RESULTS AND DISCUSSIONS

The platform test scores and exit test scores revealed the improvement of environmental problem-solving ability performed by students after using STEM project-based lesson plans as shown in Table 2. It was noted that the scores in the platform tests shown less variation in differences in all groups of student than those scores obtained in the exit tests. The results evidently pointed to difference in ability of students before and after using STEM project-based lesson plans.

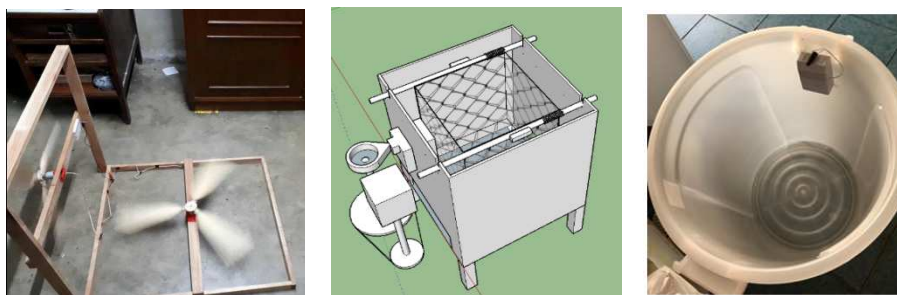
Table 2: The Platform Test Scores and Exit Test Scores in Each Group of Students

Group	Test	n	Mean	SD	T-test
High Performance students	Platform	23	3.23	0.47	*17.34
	Exit	23	10.42	0.50	
Moderate Performance students	Platform	23	2.93	0.52	*15.54
	Exit	23	9.34	0.68	
Low Performance students	Platform	23	1.44	0.51	*16.63
	Exit	23	8.90	0.98	

*p<.05, df = 22

The findings of this study were shown that (1) all students can create the STEM projects to solve an environmental problem in community (See in Figure. 2), and (2) there was statistically significant difference of environmental problem-solving ability scores before and after using STEM projects lesson plans at .05 level in all students' groups. It indicated that STEM project-based activities had a high potential to enhance the students' problem-solving ability because of three reasons. Firstly, the design of STEM project activities based on real situation and related to students' community or students' life. The students worked on the community leader, local philosophers and villagers whom they accustom. They dared to give some opinions and some ideas, and tried to solve the environmental problem by themselves. This gave them the meaningful experience and can develop their environmental problem-solving abilities within 16 weeks. Secondly, the students used the engineering and technology concepts to develop the invention for solving a problem in real situation continually. Sometimes, they faced to the similar problems; for example, the invention did not work in actual testing because of electric system problem. They tried to take more times by searching data on internet and edited the circuit until it worked appropriately. This process helped them solve the problem rapidly as the Gestalt psychology theory stated about human problem-solving ability that the person faced to the same problem, they selected the

solution to solve a problem automatically without rethinking again, and adjusted it to solve a new problem as well (McInerney, 2013). Thirdly, the asking question of teachers stimulated the students thinking to solve a problem in an individual and groups; then, It absolutely helped the students increase problem-solving thinking and discover the solution systematically. For instant, the teachers used the expressions “Do you try to search the information on website....?” or “Why do you use this method to solve a problem?”. The questions can guide the students think and find the solutions by themselves more easily. In brief, because of these above reasons, three groups of students can improve the environmental problem-solving ability via using STEM project-based activities.



**Figure 2: The Examples of Student’s STEM Projects Based on Environmental Problem in their Community
[the Fertilizer Machine, Genius Bin, and Two Dimensions Wind Generator]**

CONCLUSIONS

In conclusion, this research emphasized on the using the STEM project activity to enhance student’s ability in environmental problem-solving based on real environmental problems in students’ community in all level of student’s performance. The results indicated that the student had the meaningful learning through the direct experience and the awareness in environment conservation. Not only do they develop the problem-solving skills but also, they are promoted the development of twenty-first-century skills for students in real world and may be possible as a future work or career. The researchers expected that this study could shed the light on how the science teachers in Thailand can support their students to increase thinking ability through STEM project activity in accordance with the new science curriculum B.E.2560.

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